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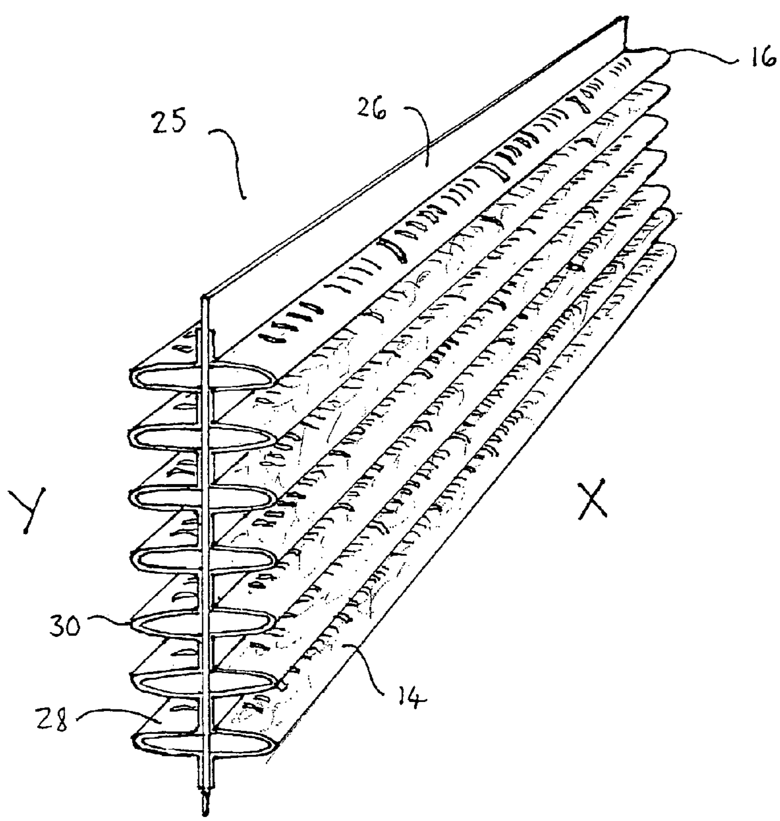
(54) Title: HEAT EXCHANGE ELEMENT



(57) Abstract: A heat exchange element comprises a formable laminate of a heat conducting layer and a liquid retaining fibrous layer. By constructing such a flexible laminate of two layers, desired properties can be imparted to the heat exchange element by forming. The laminate may be conveniently formed into heat exchange fins and attached to a heat exchange membrane for incorporation into a heat exchanger. The heat exchanger may be used to cool a first fluid by evaporation of a liquid into a second fluid operating at or near its saturation point.

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HEAT EXCHANGE ELEMENT

The present invention relates to a heat exchange element and more particularly to a laminate comprising a liquid retaining layer for use in evaporative type heat exchangers such as dewpoint coolers. The invention also relates to an evaporative type heat exchanger and a method of producing such a heat exchange element.

Dewpoint coolers are known in which a first medium circuit and a second medium circuit are thermally coupled via an at least partially heat-conducting membrane. Two respective media are then caused to flow e.g. in counterflow through the circuits, wherein at least the second medium contains a gas, for instance air, with a relative humidity of less than 100%. According to an advantageous form of dewpoint cooler known from patent application WO 03/091633 A, the heat-conducting membrane has break-up means for breaking up at least the thermal boundary layer, the laminar boundary layer and the relative humidity boundary layer at the position of at least active zones for heat transfer in at least the primary medium. These break up means are in the form of heat-conducting protrusions or fins which enlarge the effective heat-conducting surface area of said membrane and serve to conduct heat to and from the membrane. Heat-conducting surfaces of the membrane and the break-up means are at least partially covered at least in the area of the secondary medium with a hydrophilic coating, which coating is for instance porous and/or can absorb an evaporable liquid, for instance water, by capillary action, retain it and relinquish it again through evaporation, such that the wetted coating, and thereby also the heat-conducting surfaces and the break-up means, are cooled. In order to function effectively as a dewpoint cooler the first and second medium circuits are connected in such a way that a portion of the first medium is diverted to form the second medium flow after having passed through the first medium circuit.

In dewpoint coolers, the arrangement of the hydrophilic coating has been found critical to the effectiveness of cooling provided by the device. In particular, the coating must closely contact the underlying membrane or fin in order for the latent heat of evaporation to be transferred to the

evaporable liquid. Any air gap between these two layers would effectively insulate the hydrophilic layer from membrane or fin and reduce the efficiency of the device. In the above-mentioned patent application WO 03/091633 A, Portland cement is used to form the hydrophilic coating. This is sprayed directly on to the heat exchanger after forming thereof. While Portland cement has been found to provide excellent operational efficiency, it is relatively heavy, subject to flaking and is unpleasant to handle even in an automated environment.

Other devices are known where a layer is attached to a heat transfer membrane prior to forming thereof. According to US 4461733 A a layer of chopped polyester fibre flocking is attached to a plate comprising flanges, fins and depressions. The plate and fins together form a membrane separating two flow regions. The fins are thus arranged to transmit heat from one fin surface to the other and do not function to conduct heat to the membrane.

Another device is known from EP 0563474 A in which strips of fins are provided with a hydrophilic resin coating for use in the evaporator of a car air-conditioner. The coating is applied to the fins to improve drainage of the condensed water. The coating effectively completely covers the entire fin and is not considered suitable for retaining water for evaporation and for use as an evaporative cooler.

According to the present invention there is provided an improved heat exchange element comprising a heat exchange membrane and a plurality of fins connected to the membrane, the fins comprising a formable, flexible laminate of at least a heat conducting layer and a water retaining fibrous layer. The laminate may thus be conveniently formed into any desired fin shapes by known manufacturing procedures while ensuring the integrity of both the heat conducting layer and the water retaining layer.

Preferably, the water retaining layer is a woven or knitted fibrous layer. Fibres such as mineral wool may be considered. The fibrous layer may be attached to the heat conducting or carrier layer by adhesives or other similar methods. Preferably, the adhesive and the fibrous material should

be such that delaminating does not take place on forming of the laminate into a desired shape. In the case of corrugation of the laminate, it may for instance be desirable to align the weave of a woven fibrous material with the intended corrugation. Additionally, where adhesive is used, the adhesive may be chosen to enhance the properties of the carrier layer or water retaining layer. Thus the adhesive may be chosen to have water-retaining properties or heat conducting properties, or both and may thus be considered to form a part of either of these layers. Adhesive may be provided on both sides of the carrier layer prior to or during the lamination process. The adhesive on a first side of the carrier layer may serve to attach the water retaining layer while the adhesive on a second side may serve to attach the formed laminate to the membrane. Preferably at least the adhesive on the second side of the carrier layer is a heat activated adhesive.

It is desirable for use e.g. in a dewpoint cooler that the fins are provided on both surfaces of the membrane. Heat transfer can then take place from a first fin, through the membrane to a second oppositely located fin. Advantageously the heat conducting layer will be directly connected to the membrane to ensure good heat transmission thereto.

The heat conducting carrier layer may only be partially covered by the water retaining layer. Thus the heat exchange laminate may comprise covered and uncovered areas of the carrier layer, possibly in the form of a repeating pattern of bands or ribs of hydrophilic material followed by bands of uncovered carrier layer.

According to an advantageous embodiment of the invention, the heat conducting layer is formed of a metal, preferably soft annealed aluminium. The aluminium may be in the form of a foil having a thickness of between 30 and 150 microns. More preferably, the foil has a thickness of between 50 and 100 microns, ideally about 70 microns. One of the major advantages of such aluminium is that it is relatively cheap and very easy to form. It is also extremely light yet structurally very strong. Copper may also be used but is somewhat heavier. Other metals may also be considered depending upon price and weight considerations and also on the area of intended use.

According to a further embodiment of the invention the fins may be provided with louvres. It has been found that the use of such louvres is extremely advantageous in the case of a carrier provided with a water retaining layer on only a first surface. In use, the louvres may serve to guide fluid flow from the first surface to the second surface and vice-versa. Since the second surface is not covered by the liquid retaining layer, direct thermal heat transfer from the carrier layer to the fluid is enhanced.

According to a further aspect of the invention there is provided a dewpoint cooler comprising a heat exchange element as described above. The dewpoint cooler further comprises a first medium channel and a second medium channel separated from one another by the membrane, through which two channels first and second media can flow in counterflow for heat exchange through the membrane, wherein the fins serve to increase the effective heat-conducting surface area of the membrane and the water retaining layer in at least the region of the second medium can absorb an evaporable liquid, for instance water, by capillary action, retain it and relinquish it again through evaporation, such that the wetted water retaining layer and thereby also the heat-conducting layer are cooled.

Preferably the dewpoint cooler comprises at least one source of fluid pressure for causing circulation of the media through the first and second medium channels. This source of fluid pressure may be a fan or other form of blower well known in the art or may be provided by natural means such as wind or vehicle movement. For efficient operation as a dewpoint cooler, a bypass may be provided between the first medium channel and the second medium channel for circulation of a part of the first medium to form the flow of second medium. In this case a single fan may provide for circulation of the media in both channels. The dewpoint cooler may also comprise a wetting unit for subjecting the water retaining layer in at least the region of the second medium to wetting by the evaporable liquid.

According to the present invention there is also disclosed a method of manufacturing a heat exchange element as described above comprising providing a strip of heat conducting material, providing a water retaining layer in the form of a flexible mat, covering one side of the strip with the mat to form a laminate, forming the laminate into corrugations to form a series of fins and connecting the fins to a heat exchange membrane, whereby uncovered peaks of the corrugations are connected in a heat transmitting manner to the membrane. The mat may comprise a fibrous cloth or may be formed by spraying a mixture of fibres and adhesive onto the strip. By first providing the laminate and then forming it into the desired shape it is possible to achieve the desired configuration of the fins. Once the heat exchanger has been formed into a complex shape, it is otherwise difficult to attach the water retaining layer in an effective and controllable manner.

Preferably the fins are generally elongate for aligning with the medium flow direction. If the carrier layer is formed of a metal e.g. aluminium, such fins may easily be formed by roll forming machines. Openings or louvres may be made through the fins at this stage. While reference has generally been made to fins, this definition is understood to encompass other shapes of flow break up means including but not limited to dimples, ridges, grooves etc. In order to be able to effectively form such fins, louvres and other break up means, it is important that the carrier layer and water retaining layer are well bonded together to prevent unwanted delaminating or other disturbance to the integrity of the laminate.

In an advantageous embodiment of the method the laminate may be attached to the membrane by adhesive. Prior art heat exchangers have generally been formed by soldering and brazing techniques. According to an important development of the present invention, the joining of the fins to the membrane by adhesive may permit a rapid, inexpensive and light assembly. In particular, heat and pressure activated adhesives are favoured which may be provided as an integral part of the laminate or the membrane prior to forming and joining.

According to a yet further advantageous embodiment of the invention, the method may comprise providing fins on both surfaces of the membrane for heat transfer thereto. A tubular structure

may then be formed with fins on both an interior and exterior surface of the tubular structure. The tubular structure may be formed by placing two similar membranes together and sealing them along parallel edges. Alternatively, a single membrane may be folded or rolled into any desired configuration such as a structure comprising a number of fluid channels. Preferably, the fins are generally aligned with an axis of the tubular structure.

Embodiments of the present invention will now be described, by way of example only, having reference to the accompanying figures, in which:

Figure 1 is a perspective view of a section of heat exchange laminate according to the present invention;

Figure 2 is a perspective view of a heat exchange laminate formed into a strip of fins according to the present invention;

Figure 3 is a perspective view of a heat exchange element according to the present invention; and

Figure 4 is a perspective view of a tubular structure comprising a number of heat exchange elements according to Figure 3 for use as a dewpoint cooler.

According to Figure 1, there is depicted a section of a heat exchange laminate 1 illustrating the individual layers. Laminate 1 comprises a heat conducting carrier layer 2 covered over its first surface by a fibrous hydrophilic liquid retaining layer 4. A first adhesive 6 is provided between the carrier layer 2 and the fibrous layer 4. A second adhesive 8 is also provided on the second surface of the carrier layer 2. In this embodiment, the presence of second adhesive 8 is optional and its function will be described in further detail below.

Carrier layer 2 is preferably formed of soft annealed aluminium having a thickness of approximately 70 microns. This material has been found to be extremely advantageous as it is

light, easily formable and has good conductivity. The aluminium is provided on both surfaces with a primer (not shown) to ensure adequate bonding with the adhesives 6, 8. The primer is preferably a PVC based primer and may be coloured to provide a desirable appearance to the laminate 1. Further coatings e.g. to provide protection against corrosion may also be included. Although aluminium is depicted in this embodiment, other metals having similar properties may also be used including copper, tin, zinc and other alloys and combinations. Alternatively, plastics and composite materials providing good heat conduction may also be used. The selection of the above materials will be evident to the skilled man and will be determined by the particular conditions under which the heat exchanger is intended to operate.

The fibrous layer 4 is formed from a non-woven material. Although reference is made to a liquid retaining surface, it is clearly understood that the surface is in fact a liquid retaining and releasing surface. Preferably, the fibrous layer 4 has a very open structure such that the it does not insulate the carrier layer 2 from the surrounding media. An exemplary material for forming the fibrous layer 4 is a 20g/m^2 polyester/viscose 50/50 blend, available from Lantor B.V. in The Netherlands. Another exemplary material is a 30g/m^2 polyamide coated polyester fibre available under the name Colback™ from Colbond N.V. in The Netherlands. Other materials having similar properties including synthetic and natural fibres such as wool may also be used. Where necessary, the liquid retaining layer may be coated or otherwise treated to provide anti bacterial or other anti fouling properties. Alternatively the layer may be woven or knitted.

In Figure 1, the first adhesive 6 is provided as a thin layer over the entire area of the laminate 1. For use with aluminium and Lantor fibres as mentioned above, a 2 micron layer of a two component polyurethane adhesive has been found to provide excellent results. When present as such a thin layer, its effect on heat transfer to the carrier layer 4 is negligible.

Figure 2 shows a strip 14 of heat exchange laminate 1 according to Figure 1, formed into a series of fins 16 having the liquid retaining layer 4 on a first upper surface thereof. The fins 16 are each provided with louvres 18 in the form of elongate slots penetrating through the laminate 1 (only

the louvres on the first fin are shown). The louvres 18 are arranged in groups. A first group 20 serves to direct flow into the surface, while a second group 22 directs flow out of the surface. Thus, some of the air flowing along the fins 16 in the direction of arrow A will be directed through the laminate towards the lower second surface. Air following the direction of arrow B will be directed outwardly by the second group of louvres. In this way, the air alternately flows over the first surface, where it can receive moisture by evaporation from the liquid retaining layer, followed by the second surface where it can receive direct thermal energy to raise its temperature.

In addition to their function in directing flow between the surfaces of the fins 16, louvres 18 also serve to further break up the boundary layers that may develop as air flows along the surfaces. Other break up elements may be provided in addition or instead of the louvres 18. Furthermore, while the fins 16 of Figure 2 are straight, curvilinear or zig-zag fins may also be produced. It is believed that such fin shapes are advantageous in breaking up the boundary layers that develop in flow along the fins, since each time the fin changes direction, turbulent flow is re-established. Various cross-sectional shapes are also possible for the fins, including corrugations of square, trapezoidal, rectangular, bell and sine wave shapes. The precise shape will depend on various factors, one of which may be the ability of the liquid retaining layer 4 to resist bending.

In addition to louvres 18, fins 16 are provided with conduction bridges 24. These bridges 24 are in the form of cuts through the laminate 1 over substantially the whole height of the fin 16. They serve to prevent unwanted transport of heat along the fins 16 in the direction of the air flow.

The fins 16 are preferably formed using standard corrugation techniques. An appropriate width roll of the prepared laminate 1 may be fed through a pair of corrugated rollers which can form the fins 16, louvres 18 and heat bridges 24 in a single pass. The resulting product may then be cut into suitably sized strips 14 for further processing.

Figure 3 shows a possible construction 25 using the strip 14 of Figure 2. According to Figure 3 the fins 16 are attached to a first surface of a membrane 26. The membrane 26 is provided on its second surface with a second strip 28 of fins 30 similarly shaped to the fins 16 and which may also be provided with louvres and conduction bridges. The second strip 28 differs from the first strip 14 in that it does not comprise a liquid retaining layer. The membrane 26 is generally impervious to the air or other fluid intended for use in the heat exchanger and serves to define a first fluid region X and a second fluid region Y. For constructional reasons, a preferred material for the membrane is soft annealed aluminium of approximately 70 micron gauge.

As described above, the heat exchange laminate 1 forming heat exchange element 14 may have a second adhesive 8 on its second surface. This second adhesive 8 is preferably a heat seal adhesive such as a PVC/polyacrylate based adhesive. The membrane 26 is also provided with a similar or compatible heat seal adhesive on its surface facing the strip 14 whereby both membrane 26 and strip 14 may be easily joined together under appropriate heat and pressure. The facing surfaces of second strip 28 and membrane 26 are also provided with similar heat seal adhesive and may be joined together in the same way. As can be seen from Figure 3, the strips 14 and 28 are joined in such a way that only the troughs of the fins 16, 30 are adhered to the membrane 26. Furthermore, the fins 16 and 30 are directly aligned with one another through the membrane 26.

In use, the fluid region X may serve as the wet side of an evaporative heat exchanger or humidifying device, while region Y serves as the dry side. The fins 16 comprising laminate 1 can take up a quantity of water in the liquid retaining layer 4. Non-saturated air flowing across the surface can absorb water by evaporation out of the laminate 1. In so doing, laminate 1 loses a quantity of heat corresponding to the latent heat of evaporation of the water lost. To maintain equilibrium, heat must be provided to the laminate 1. For a carrier layer 2 of aluminium, this takes place by conduction in the plane of the laminate from the membrane 26. This heat must in turn be supplied by the cooling of dry fluid in region Y and by conduction of this heat through

the fins 30 to the membrane 26. The alignment of the fins 16, 30 improves heat transfer from one element to the other through the membrane 26.

In the illustrated embodiment only a single side of the fins 16 is provided with a liquid retaining layer. It is however also possible to provide a liquid retaining layer on other surfaces too. Membrane 26 may for instance also be formed of heat exchange laminate 1, having the liquid retaining layer on its first surface facing the strip 14. It is also possible to use the heat exchange laminate 1 for forming the second strip 28 and/or to provide liquid retaining layers on both sides thereof. For laminates provided with a liquid retaining layer on both surfaces, additional measures and adhesive layers may be required to ensure joining to another surface.

In the illustrated embodiment, the fins 16 and 30 are arranged to lie parallel to one another such that the heat exchanger may operate in counter flow. For use as a dew-point cooler, the membrane may be provided with channels allowing some or all of the fluid in the region Y to pass across the membrane to region X. Such channels may be in the form of orifices through the membrane. Other alternative arrangements are also possible with the two sets of fins angled with respect to each other for cross flow operation. For cross flow operation as a dew-point cooler, it may also be possible to provide orifices through the membrane between one or more of the fins 30 to serve as feeders for some or all of the channels between the fins 16 in the region X.

The construction 25 according to Figure 3 may be integrated into a heat exchanger such as a dew-point cooler in many different ways. A number of like constructions 25 may be arranged parallel to one another to form a series of alternate fluid regions X and Y. Clearly, if a number of such constructions 25 are combined, more than two regions may be defined each being subjected to a different fluid. In an advantageous alternative, the construction 25 may be formed into a tubular structure by rolling or folding the membrane and heat sealing it to itself, whereby the region Y is located within the tube and the region X is located externally.

Figure 4 shows a possible tubular structure 32 that has been found particularly advantageous for the construction of dew-point coolers elements and heat recovery elements. Tubular structure 32 comprises a pair of constructions 25 comprising membranes 26 that have been joined to one another at upper and lower longitudinal edges 34, 36. Various methods for joining the edges 34, 36 may be used, but a preferred method for aluminium membranes 26 as described above is by heat sealing. A wetting unit 50 provides an evaporable liquid.

The constructions 25 are effectively connected in back to back relationship with the strips 28 on the inside and the strips 14 with liquid retaining layer 4 on the outside. A reversal of this arrangement is also possible but would require water supply to the interior of the tubular structure 32 in order to wet the liquid retaining layer 4. As can be seen from Figure 4, the outside of each membrane 26 is provided with a plurality of srips 14, separated from one another by a short gap. This gap also serves as a form of conduction bridge to minimise heat conduction in the flow direction of the heat exchanger.

Also shown in Figure 4 is an inlet extension 38 (partially cut away) and an outlet extension 40 for the interior of the tubular structure 32. Both extensions 38, 40 are formed from sections of the membranes 26 without fins. A web 42 is also shown between the two constructions 25. The web 42 serves to improve structural stability and may be provided with holes to allow flow through it within the interior of the tubular structure 32.

In use as a dew-point cooler, one or more such tubular structures 32 are located within a suitable housing having an inlet communicating with the inlet extension and an outlet communicating with the outlet extension. Flow C through the tubular structure 32 may be induced by a fan 52 provided at the inlet although other flow inducing means may also be used. By providing e.g. a flow restriction at the outlet and a bypass connection between the outlet extension and the outside of the tubular structure 32, a portion of the flow D may be caused to recirculate in contra-flow over the outside of the tubular structure 32. The remainder of the flow E exits to the outlet for cooling of the desired space. Liquid such as water supplied to the liquid retaining layer 4 by

wetting unit 50 will then evaporate into the recirculating flow D providing the necessary cooling to the flow C within the tubular structure 32. The recirculating flow D may then exhaust through a further exhaust opening provided in the housing.

A slight adaptation may be made for use also as a heat recovery device. The housing may then be provided with a further inlet and possibly a second fan or other flow inducing device. Whichever flow is intended to be heated may also be provided with water supply to an appropriate liquid retaining layer for humidification purposes. For heat recovery it is also particularly advantageous to provide both sides of the exchanger with laminates comprising liquid retaining layers according to the present invention, whereby condensation is retained and can be wicked away.

While the above examples illustrate preferred embodiments of the present invention it is noted that various other arrangements may also be considered which fall within the spirit and scope of the present invention as defined by the appended claims.

CLAIMS

1. A heat exchange element comprising a heat exchange membrane and a plurality of fins connected to the membrane, the fins comprising a formable, flexible laminate of at least a heat conducting layer and a fibrous water retaining layer.

2. The heat exchange element according to claim 1, wherein the water retaining layer is a woven or knitted fibrous layer.

3. The heat exchange element according to claim 2, wherein the water retaining layer comprises mineral wool.

4. The heat exchange element according to claim 1, wherein the water retaining layer comprises an adhesive layer containing fibres.

5. The heat exchange element according to any preceding claim, wherein fins are provided on both surfaces of the membrane.

6. The heat exchange element according to any preceding claim, wherein the heat conducting layer is connected to the membrane for heat transmission thereto.

7. The heat exchange element according to any preceding claim, wherein the heat conducting layer is only partially covered by the water retaining layer.

8. The heat exchange element according to any preceding claim, wherein the heat conducting layer is a metal.

9. The heat exchange element according to any preceding claim, wherein the fins are provided with louvres.

10. A dewpoint cooler comprising a heat exchange element according to any preceding claim, the dewpoint cooler comprising a first medium channel and a second medium channel separated from one another by the membrane, through which two channels first and second media can flow in counterflow for heat exchange through the membrane, wherein the fins serve to increase the effective heat-conducting surface area of the membrane and the water retaining layer in at least the region of the second medium can retain an evaporable liquid and relinquish it again through evaporation, such that the wetted water retaining layer and thereby also the heat-conducting layer are cooled.

11. The dewpoint cooler according to claim 10, further comprising at least one source of fluid pressure for causing circulation of the media through the first and second medium channels.

12. The dewpoint cooler according to claim 10 or claim 11, wherein a bypass is provided between the first medium channel and the second medium channel for circulation of a part of the first medium to form the flow of second medium.

13. The dewpoint cooler according to any of claims 10 to 12, further comprising a wetting unit for subjecting the water retaining layer in at least the region of the second medium to wetting by the evaporable liquid.

14. A method of manufacturing a heat exchange element comprising:
providing a strip of heat conducting material;
providing a water retaining layer in the form of a flexible fibrous mat;
covering one side of the strip with the mat to form a laminate;
forming the laminate into corrugations to form a series of fins; and

connecting the fins to a heat exchange membrane, whereby uncovered peaks of the corrugations are connected in a heat transmitting manner to the membrane.

15. The method according to claim 14, wherein the mat comprises a woven or knitted fibrous cloth.

16. The method according to claim 14, wherein the mat is formed by spraying a mixture of fibres and adhesive onto the strip.

17. The method according to any of claims 14 to 16, further comprising the formation of louvres through the laminate prior to connection to the heat exchange membrane.

18. The method according to any of claims 14 to 17, wherein the strip of heat conducting material comprises a metallic layer.

19. The method according to any of claims 14 to 18, wherein the heat exchange membrane comprises a metallic layer.

20. The method according to any of claims 14 to 19 further comprising folding the membrane to form at least two fluid channels separated from one another by the membrane.

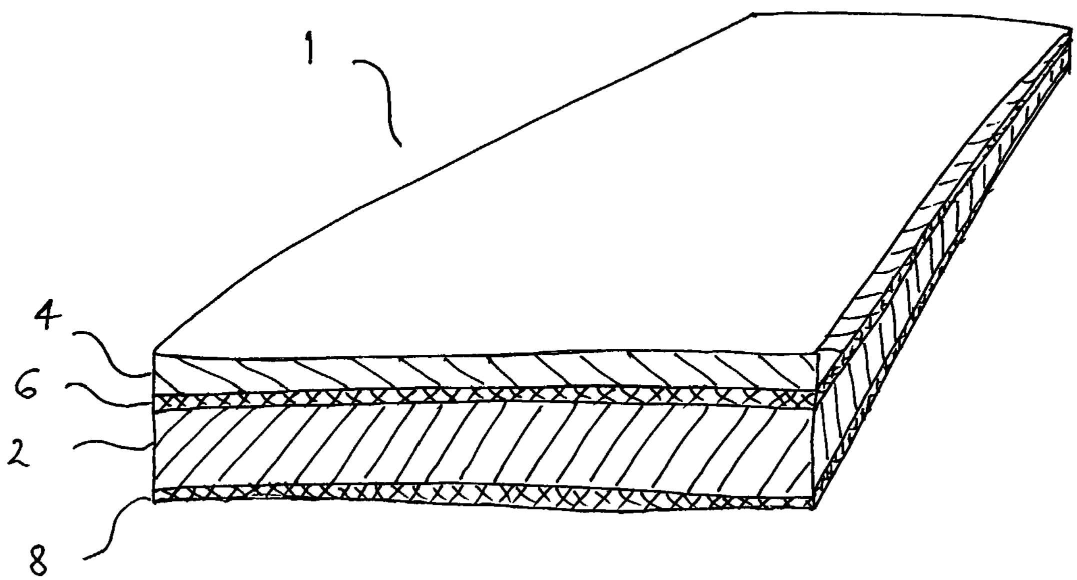

Fig. 1

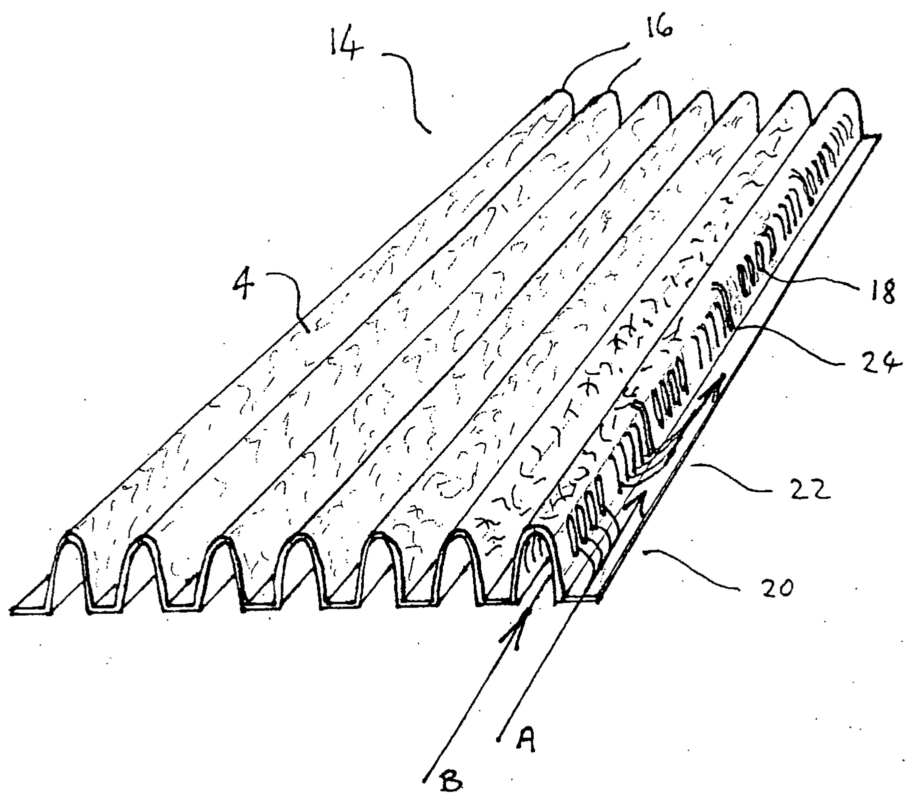

Fig.2

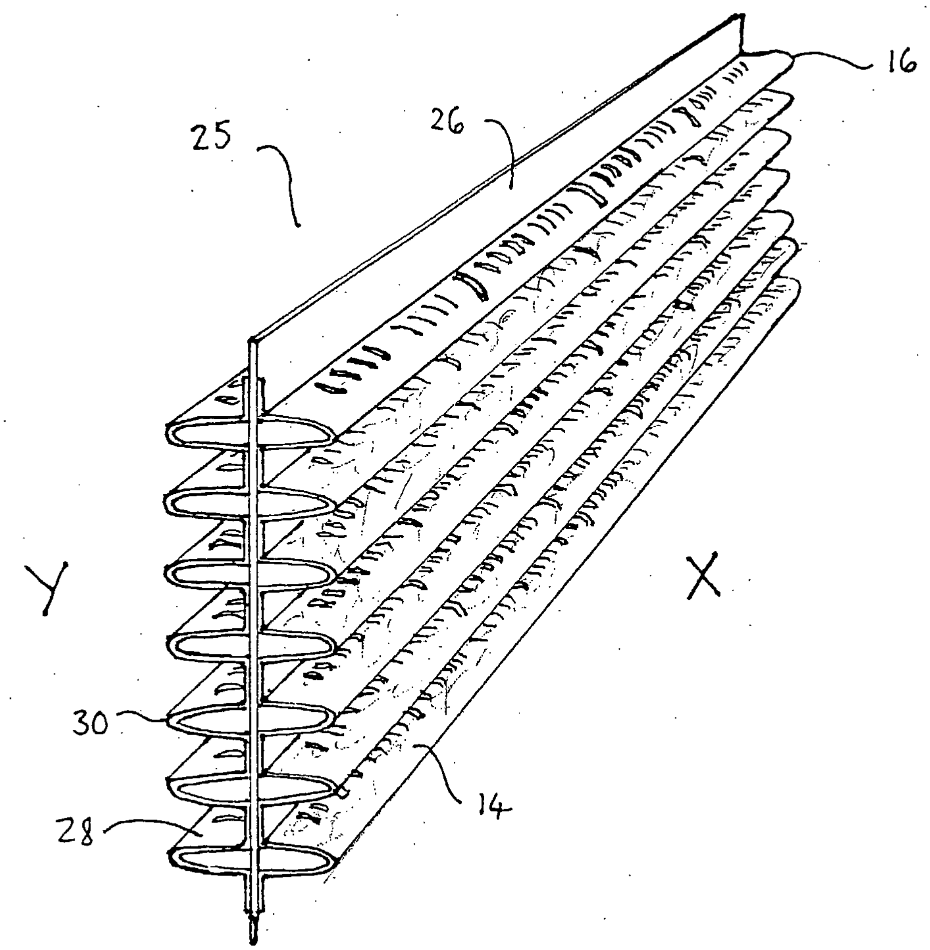

Fig.3

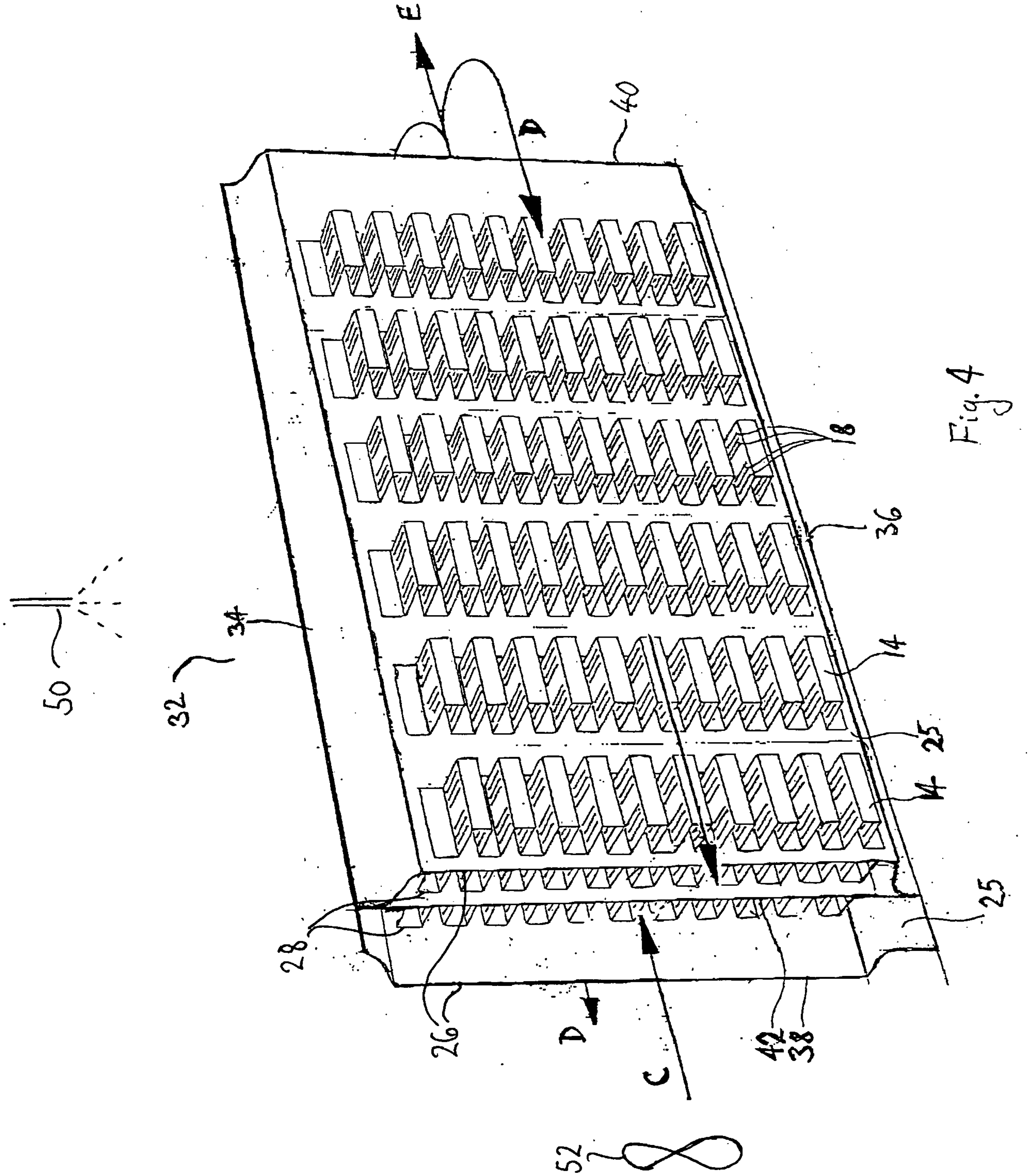

Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2004/009366

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F24F5/00 F28D5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F24F F28F F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	EP 0 859 203 A (BERBEN ERNEST ; HECKE ANTONIUS VAN (NL)) 19 August 1998 (1998-08-19) the whole document -----	1,2,7,8, 14,15, 18-20 9-14,17 16
Y	US 5 301 518 A (KANACHINE SERGUEI P ET AL) 12 April 1994 (1994-04-12) column 8, line 9 - line 21 column 8, line 55 - line 61; figures 1-4 -----	10-14
Y	WO 03/016808 A (IDALEX TECHNOLOGIES INC) 27 February 2003 (2003-02-27) figure 11 -----	9,17
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 December 2004	29/12/2004

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European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	De Graaf, J.D.

INTERNATIONAL SEARCH REPORT

International Application No
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